ABSTRACT

Diesel Emission Reduction Efforts in the Office of Heavy Vehicle Technologies

Ronald L. Graves
Oak Ridge National Laboratory

The Office of Heavy Vehicle Technologies has adopted aggressive goals for low emissions in its program to further improve diesel engine efficiency and expand their use. Engine fuel economy and emissions are very much entwined and must be approached systematically. When the Environmental Protection Agency (EPA) first began regulating diesel emissions in the mid-to-late 1970's, trucks typically had emission values of 10-15 g/bhp-hr of NOx and 1 g/bhp-hr of particulate matter (PM). Over the past twenty years engine manufacturers have made significant improvements by retarding timing, increasing the injection pressure, and capitalizing on other design changes. Today's heavy-duty diesel engines emit just under 5 g/bhp-hr of NOx and 0.10 g/bhp-hr of PM. Current legislation mandates a reduction of NOx levels to 4 g/bhp-hr by 1998, and the EPA and major engine manufacturers have issued a "Statement of Principles" that requires further reduction by 2004 to 2.4 g/bhp-hr NOx plus hydrocarbons (HC) and 0.05 g/bhp-hr PM. Meeting these stringent emission standards while at the same time improving engine efficiency constitutes a major challenge for diesel engine manufacturers.

Expanding the use of these latest high-efficiency diesel engines into other vehicle sectors such as light trucks and sport utility vehicles represents a tremendous fuel conservation potential. This "dieselization" strategy, however, will occur only if:

1. An efficient diesel engine is made emissions-legal to offer for sale.
2. The diesel option is attractive to consumers so they will select it over less efficient spark ignition engines.

Emission certification of diesel engines for pickups and sport utility vehicles (SUVs) under 8500 pounds gross vehicle weight rating (gvwr) is even more challenging than certification for heavy trucks because of tiered structure of emissions standards and different test procedures for heavy and light duty vehicles. Pickups and SUVs under 8500 pounds gvwr must be certified as light duty trucks using the same Federal Test Procedure (FTP) on a chassis dynamometer as for passenger cars. The regulations for NOx and PM for light-duty trucks are relatively more stringent than those for heavy-duty diesel engines that are certified over the engine dynamometer Federal Transient Test Procedure. The highly popular Cummins and Navistar direct injected (DI) diesels, available in full-size Dodge and Ford pickups respectively, are certified as heavy duty diesel engines. Preliminary analysis, converting engine emissions (g/hp-hr) to vehicle emissions (g/mi), suggests that today's DI diesel engines, hypothetically packaged for a smaller vehicle, would exceed light duty NOx standards by a factor of two or three in their present state of tune. Hence, application of the most efficient diesel technology in a smaller package appears to carry a substantial emissions barrier.

To address this challenge one can consider emissions reduction strategies from two general approaches: (1) minimizing the pollutants coming immediately out of the engine (engine-out emissions), and (2) cleaning the engine emissions to an acceptable level before exhausting to the environment (exhaust aftertreatment). A combination of combustion control technologies, including EGR, fuel injection controls, plus fuel formulations and aftertreatment give the engine developer the greatest flexibility in meeting efficiency, emissions, and cost targets.